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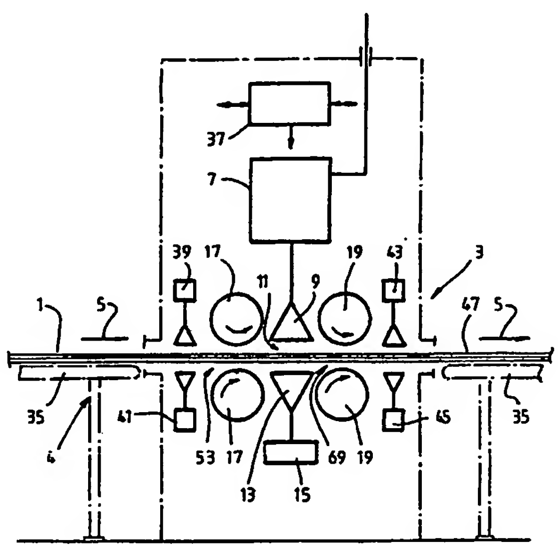

(57) Abstract

Process and apparatus for the production of a laminate (47), such as of glass sheets (49). The process includes the steps of providing an assembly (1) comprising at least two sheets (49) of material arranged in co-planar relation; generating electromagnetic energy, such as microwave energy, and radiating the energy into the assembly (1) in a heating zone (11) extending through the assembly. There is relative movement of the sheets (49) to the electromagnetic energy so that the zone (11) traverses the whole of the area of the sheets which are to be laminated.

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PROCESS AND APPARATUS FOR PRODUCING A LAMINATE

FIELD OF THE INVENTION

The present invention relates to a process and apparatus for the production of a laminate and relates particularly, but not exclusively, to a process and apparatus for the continuous production of a laminate such as of glass.

DESCRIPTION OF THE PRIOR ART

Early this century, processes for laminating glass became viable with the discovery and use of cellulose materials as interleave materials between the sheets of glass. However, these interleave materials were not stable in the presence of sunlight and a colour change tended to occur rapidly, the material turning yellow and becoming less transparent. More recently interleave materials based on

vinyl, for example poly-viny-butyrate (P.V.B.), were developed which have much more stable characteristics, at least in terms of colour stability, particularly in the presence of ultra-violet light. The bonding characteristics of these latter materials to glass requires closely controlled processes and pre-bond environment in order to achieve a satisfactory bond which will satisfy industry standards.

The critical parameters in the bonding process are: glass cleanliness, including remnant surface deposits of chemicals from any washing process; lack of surface moisture; moisture contents in the interleaved material; uniform applied pressure across the glass-interleave-glass assembly during bonding; absence of excess air in the assembly immediately prior to bonding; and, the temperature of the interleave material, as related to plastic flow capability. The clarity of the finished bond, as measured by optical transmission loss, is dependent on the percentage bond attachment area and the dispersion of finely divided air or gas bubbles in the interleave material. Bond retention, or the capability of the bond to hold together, is temperature dependent with typical separation or weaken temperatures in the region of 70/80°C.

With such vinyl based interleave materials, the act of bonding is temperature independent and there have been several alternative methods developed for obtaining bonds, such as flooding the interleave space with plasticiser and applying pressure to exclude air and to force a close contact between glass surfaces and the interleave material. Various methods have been employed for applying heat and pressure to laid-up assemblies, including the so called pre-press furnaces, the commonly used autoclave, and vacuum presses. More recently a form of plastic welder has been developed, which treats the assembly as a type of lossy capacitor in a tuned circuit driven from an RF source. This latter method, whilst more modern in concept, has severe technical and practical limitations being restricted to production of very

small assemblies and unsuited to a production line process. More importantly, and in common with all of the above mentioned methods, it is fundamentally a batch process.

STATEMENT OF THE INVENTION

The present invention was developed with a view to providing an improved technique for the production of a laminate, one embodiment of which enables continuous production of the laminate.

According to one aspect of the present invention there may be provided a process for producing a laminate, said process including the steps of,

(a) providing at least two webs of suitable material to be laminated and placing the webs in co-planar relation,

(b) generating electromagnetic energy and radiating said energy in a zone smaller in area than the area of the opposed surfaces of the webs, said zone extending in a direction through the thickness of said webs,

(c) providing relative movement of said electromagnetic energy to said webs so that the zone will traverse substantially the whole of the opposed surfaces of said webs where lamination is required,

the radiating of said energy in said zone being such as to cause absorption of electromagnetic energy to effect heating to laminating temperatures, and

(d) allowing laminating of said webs following said heating.

According to another aspect of the present invention there may be provided apparatus for laminating webs of suitable material, said apparatus including means for receiving said webs in co-planar relation,

electromagnetic energy radiating means for radiating electromagnetic energy in a zone smaller in area than the opposed surfaces of the webs, said zone extending through the webs,

means for permitting relative movement of said electromagnetic energy to said webs so that said zone will traverse substantially the whole of the opposed surfaces of

said webs where lamination is required, the radiating means being such that electromagnetic energy will be absorbed in said zone to effect heating to laminating temperatures to allow laminating.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more clearly ascertained a preferred embodiment will now be described, by way of example only, with reference to the accompanying drawings. Although the following description relates specifically to laminating glass from sheets or webs of glass material, it will be understood that the invention is equally applicable to the production of a laminate from webs of any other suitable material(s).

Figure 1 is a schematic block diagram of a preferred embodiment of the apparatus for producing a glass laminate;

Figure 2 is a schematic diagram of an assembly of two sheets of glass with an interleave material sandwiched therebetween, prior to bonding;

Figure 3 illustrates the assembly of Figure 2 after bonding;

Figure 4 is a graph showing variation in temperature of the interleave material at a point in laminate; and

Figures 5(a) and 5(b) illustrate schematically a preferred microwave horn and its electromagnetic power spatial distribution.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring to Figure 1 there is shown a preferred embodiment for continuous production of laminated glass. In this embodiment, an assembly 1 of two or more webs of material such as sheets of glass with an interleave material sandwiched therebetween is caused to move continuously relative to the apparatus 3, in the direction of the arrows 5 as shown by conveyor means 4. The apparatus 3 comprises an electromagnetic energy generating means 7 connected to an electromagnetic energy radiating means 9 arranged above the assembly 1 and in close proximity to an upper surface thereof. Preferably, the generating means 7 is a microwave energy

source and the radiating means 9 comprises one or more microwave transmitting horn antennas. The radiating means 9 radiates microwave energy into the assembly 1 in a heating zone 11 extending through the assembly 1. Some of the incident microwave energy is absorbed by the glass and the interleave material under the radiating means 9, whilst the remaining energy is collected by electromagnetic energy receiving antenna 13, such as a horn, where it is measured for control purposes and then dissipated as waste heat in a load 15. Nip rollers 17 are provided upstream of the radiating means 9 and the receiving antenna 13 and are used to remove excess air from the assembly 1 by subjecting it to a squeezing pressure. Similarly, nip rollers 19 are provided downstream of the radiating means 9 and the receiving antenna 13 in order to apply a localized squeezing pressure to the assembly 1 to enhance a bonding effect in the assembly 1 resulting from heating in the heating zone 11.

There are basically two types of microwave energy sources that may be used for the generating means 7. These can be an oscillator such as a CW magnetron or an amplifier, separately driven, typically comprising a power klystron. In general, magnetrons are much cheaper on a dollar/kilowatt basis, provided any controlling problems encountered are not too severe. There is only an indirect relationship between magnetron power and overall glass sheet size in so far as the heating zone 11 is of relatively small dimensions, for example 5 cm in the direction of movement and a fixed maximum in the lateral direction across the sheets.

Selective heating of the interleave material in preference to the glass is achieved by selecting the frequency of a radiating beam of electromagnetic energy so that the interleave material absorbs substantially more of the incident energy than the sheets of glass. The preferred frequency of operation is that which produces a typical absorption ratio of 4 to 1, where a ratio of 10 to 1 is seen to be more than adequate and any higher ratio of no additional benefit. To

demonstrate the kind of energy requirements and power losses involved, the following example is given, assuming the following attenuation figures:

Glass attentuation 0.5 dB per 3 mm.

P.V.B. film interleave material attenuation 8 dB per 0.38 mm.

A three layer sandwich composed of a glass sheet of 3 mm thickness, a P.V.B. film interleave material of 0.38 mm thickness and a glass sheet of 3 mm thickness is assembled and placed normal to the radiating means 9 at a point distant therefrom where the incident power on the first incided glass sheet is 1000 watt at a given frequency. The power dB ratio is given by the following formula:

$$\text{dB power} = 10.\log_{10} \frac{P1}{P2} \quad \text{where } P_1 = \text{power out(in)}, \; P_2 = \text{power in(out)}$$

$$\text{Total system loss} = 0.5 + 8.0 + 0.5 \text{ dB}$$
$$= 9.0 \text{ dB}$$
$$P_1 = 1000.\text{antilog } 9.0$$
$$= 125.89 \text{ watt}$$

The power value calculated is that power emanating from the remote side of the assembly 1 to be collected and dissipated in the load 15. The power at the first glass/P.V.B. interface is 891.25 watt and at the second interface 141.25 watt repeating the same calculations using 0.5 and 8.5 dB respectively. Subtraction will give the power dissipation in each layer as follows:

First sheet of glass: 1000 - 891.25 = 108.75 watts.

P.V.B. film interleave material: 891.25 - 141.25 = 750 watts.

Last sheet of glass: 141.25 - 125.89 = 15.36 watts.

For the attenuation figures assumed, 75% of the incident energy is usefully employed in heating the P.V.B film and the absorption ratio of P.V.B. film/first glass sheet is 6.9 to 1 which is an acceptable figure.

It will be apparent that the arrangements of this embodiment may be readily adapted to alternative compositions of the assembly 1. An increase in P.V.B. film thickness will cause a change in attentuation rate in the P.V.B. film.

Accordingly, the design of the radiating means 9, such as a horn antenna, is critical and to some degree is dependent on the characteristics of the various materials comprising the assembly 1. Similarly, the number of radiating means 9, such as a plurality of horns, used to span a particular width of the assembly 1, will be set by the particular material characteristics of the assembly 1.

Referring to Figures 5(a) and 5(b), there is shown schematically a preferred microwave transmitting horn 23 with a corresponding preferred spatial power distribution curve 25 shown graphically thereunder. Figure 5b illustrates a side elevation of the horn 23 together with a typical lateral power distribution curve 25 showing flatness variations caused by or minimized by the manipulation of known tuning elements 27. Microwave energy supplied to the antenna input wave guide 2a is radiated by the horn 23 as modified by the tuning elements 27 in a downwards direction, in order to achieve the relatively flat spatial power distribution within a power flatness tolerance band 31 and so create the effect of substantially uniform power across the assembly 1 within the heating zone 11. The cross-over point 33 for adjacent horn power distribution curves is selected so that the sum of both curves will place the net power within the power flatness tolerance band 31. Figure 5a shows an end view of the horn 23 together with a typical power distribution curve 25 in the direction of glass travel.

The preferred embodiment of the apparatus 3 has the conveyor means 4 for providing continuous movement of the assembly 1 relative to the heating zone 11. This conveniently comprises, a conveyor belt 35 or other transport mechanism with variable speed control. Preferably the apparatus 3 is provided with a control means 37, comprising a computer, which is operatively connected to nip rollers 17 and 19, the

microwave energy radiating means 9 and the conveyor belt 35 in order to control the speed of movement of the assembly 1 relative to the radiating means 9, and the pressure applied by the nip rollers 17 and 19, and the microwave energy power level. The control means 37 is also supplied with feedback signals from microwave absorption rate sensors 39 and 41 arranged upstream of the heating zone 11, and from optical sensors 43 and 45 arranged downstream of the heating zone 11. Microwave absorption rate sensors 39 and 41 are provided in order to measure the attenuation characteristics of the materials comprising the assembly 1 in order to control the amount of incident power required in the heating zone 11 and the speed at which the assembly 1 moves relative to the heating zone 11. Optical sensors 43 and 45 provide feedback as to the quality of the laminate 14 expressed in optical transmission terms.

It will be apparent to those skilled in the art that with the control means 37, comprising a computer arranged as described, a materials testing programme may be developed whereby a large number of samples of the sheets of material and interleave materials to be employed may be tested, and the data placed in memory for subsequent processing. The raw data collected in this manner can subsequently be processed and averaged over the frequency range, and the broad band attentuation curves for the different materials compared to find compatible discrete frequencies that satisfy both relative attenuation rates and suitable frequencies for available microwave energy sources. The relative attentuation rates will also set the required incident microwave power and hence the mechanical dimensions for the transmit and collecting horns.

The power absorbed by the P.V.B. film as it travels through the heating zone 11 will be a function of the incident power and the speed at which the assembly 1 travels. A control algorithm may be programmed into the computer based on

the raw data so that the apparatus 3 may be automatically adjusted so as to be capable of processing any combination of assembly materials within predetermined constraints.

A preferred process for producing a laminate of glass, using the apparatus illustrated in Figure 1, will now be described. A glass laminate assembly prior to bonding is shown in Figure 2, where two sheets of glass 49 have an interleave material 51 sandwiched therebetween. An air gap 53 formed between the initially rough surface of the interleave material 51 and the inside surface of the glass sheets 49 represents a relatively high thermal impedance effectively insulating the interleave material 51 from the glass sheets 49. The continuous bonding process of this embodiment requires selective heating of the interleave material 51 to a sufficiently high temperature to allow gas absorption and plastic flow to occur in a very short time, without significant heating of the glass.

The characteristics of P.V.B. as an interleave material are well documented, including its ability to absorb gases and to form bonds with a glass surface making it particularly well suited for bonding webs of glass together to form a glass laminate. The bonding process in this embodiment is dynamic in that after heating and plastic flow occurs there is a rapid loss of energy from the interleave material 51 to the cold glass sheets 49 caused by a gross reduction in the thermal impedance between glass sheets 49 and interleave material 51.

The above process is perhaps best described with reference to Figures 1, 2, 3 and 4 of the accompanying drawings. At point 53 in Figure 1 the assembly 1 appears as shown in Figure 2. The entry nip roll action applied by nip rollers 17 reduces the amount of air in the assembly 1 to a small fraction, typically 1%, of that amount which the interleave material 51 could absorb in a more prolonged bonding process. The point 53 in the assembly 1 then enters

the heating zone 11, where the interleave material 51 is subjected to selective heating by means of microwave energy absorption as above described.

Referring to Figure 4, which shows the change in temperature and circumstances of a point 54 or lateral line in the P.V.B. (and glass); point 54 is the initial temperature of the assembly immediately prior to entry into the heating zone 11 (i.e. equilibrium). Shaded line 55 represents the time during which the point 54 in the assembly 1 is subjected to radiated microwave energy, whilst curve 57 represents the variation in temperature of the P.V.B. film interleave material. Curve 59 represents the variation in temperature of the inner surfaces of the glass sheets 49, whilst curve 61 is the glass mean temperature averaged over the web cross section. Time 63 is the approximate point on the P.V.B. curve where plastic flow commences.

After plastic flow commences the P.V.B. interleave material 51 assumes the shape of the contacting glass surfaces 49 and a small change in the overall thickness dimension of the assembly 1 will be observed. The assembly 1 now appears as illustrated in Figure 3, where the high thermal impedance air space 52 of Figure 2 has been replaced with a low thermal impedance interface 65. Any remaining air in the assembly is very quickly absorbed into the surfaces of the interleave material 51 during plastic flow.

The line 67 shown parallel to the P.V.B. temperature curve in Figure 4 represents the glass chilling effect as energy absorbed by the interleave material 51 is conducted into the glass sheets 49. It should be noted that prior to the commencement of the chilling effect, the point 54 in the assembly, with which we are concerned, has passed through the heating zone 11 and is now at approximately point 69 in Figure 1 of the production process. Time 71 in Figure 4 is the approximate point of the P.V.B. temperature curve where plastic flow is completed, the interface air gap vanished and all gas absorbed.

Also, Figure 4 shows schematically the approximate travel distance 73 during the interface air gap reduction process. Point 75 is where plastic flow commences and point 77 is where it is completed. Distance 79 represents the distance travelled by a point in the assembly, during which the bonding effect takes place, whereby the sheets of glass 49 are bonded together to form a laminated glass web 47. To enhance the bonding effect the assembly 1 is subjected to a further squeezing pressure by nip rollers 19 at some point along distance 79, where bonding broadly occurs. At point 81 the assembly 1 enters an energy redistribution phase where the glass sheet 49 and the P.V.B. interleave material 51 approach the same temperature. It should be noted that the actual process of lamination in the glass P.V.B. assembly is in the opposite direction to the direction of motion of the assembly 1 through the production process.

After the process has taken place, the air or gas distribution in the interleave material 51 will have reached equilibrium and will be uniformly distributed across the interleave cross-section. If necessary, a further step in the production process involves annealing the laminate 47 to hasten the gas equilibrium process in the interleave material 51, and so reach optimum optical clarity in a shorter time. Such annealing may be carried out by further application of microwave energy at a power rate sufficient to increase gas mobility in the interleave material but not at a level to cause plastic flow to occur and thus risk possible glass separation.

By irradiating the assembly from one side only, multiple layer fabrication is possible as the bulk of incident energy is absorbed in the interleave layer nearest the horn of the radiating means 9. The balance of energy remaining is too small to sensibly raise the temperature of the already bonded interleave material(s) in the underlying layers of the laminate. By using the same calculations as above and

assuming the same attentuation figures, a multiple lamination formed by multiple passes can be illustrated by the following example:

A five layer sandwich is assembled comprising a first glass sheet 3 mm, P.V.B. 0.38 mm, second glass sheet 3 mm, P.V.B. 0.38 mm and a third glass sheet 3mm. The power dissipation in each layer, starting with the top side glass sheet, is as follows:

First glass sheet 108 watt,
First P.V.B. interleave material 750 watt,
Second glass sheet 16 watt,
Second P.V.B interleave material 105 watt,
Third glass sheet 3 watt.

Of the 1000 watt of incident power only 17 watt will be collected by the horn of the receiving antenna 13 to be dissipated in load 15. It should be noted that the bulk of the energy is absorbed in the first P.V.B. layer of the four layer assembly and that the power dissipated in this layer remains the same as with the three layer assembly. It follows that any number of layers could be assembled to form a multi-layer laminate whilst employing the same incident power, although multiple passes would be required.

Although the above description of the preferred embodiment of the process and apparatus relates to the production of a glass laminate wherein an interleave material is employed for bonding the webs of glass together, it will be appreciated that the apparatus and process according to the invention are equally applicable to the bonding of sheets or webs of material to form a laminate where no interleave material is involved. In this situation the heating by absorption of electromagnetic energy produces a heat bonding effect at the interface of the sheets or webs of material arranged in coplanar relation.

Instead of moving the glass sheets or webs relative to the radiating means 9, the radiating means 9 could be moved relative to the glass sheets or webs. This alternative is to be considered within the scope of the invention.

It should be appreciated that there is provided a process for producing a laminate, said process including the steps of,

(a) providing at least two webs of suitable material to be laminated and placing the webs in co-planar relation,

(b) generating electromagnetic energy and radiating said energy in a zone smaller in area than the area of the opposed surfaces of the webs, said zone extending in a direction through the thickness of said webs,

(c) providing relative movement of said electromagnetic energy to said web so that the zone will transverse substantially, the whole of the opposed surfaces of said webs where lamination is required,

the radiating of said energy in said zone being such as to cause absorption of electromagnetic energy to effect heating to laminating temperatures, and

(d) allowing laminating of said webs following said heating.

Said process also includes the further step of providing an interleave between the webs and wherein said heating heats said interleave in said zone to laminating temperatures.

Also, there is continuous relative movement of said at least two webs relative to said zone to provide for continuous laminating.

The process also includes the further step of applying a squeezing pressure to the opposed faces of said webs to enhance said laminating.

The squeezing pressure is applied to an area of said webs upstream of said zone whereby to minimize the volume of air between the webs.

The squeezing pressure is applied to an area downstream of said zone.

Also a further web is laminated to said laminate by a further relative movement of said further web to said zone.

Also said further web is closer to a source of said electromagnetic energy than said laminate whereby there will be greater energy absorption between said further web and said laminate, than between the webs in said laminate.

There is also provided apparatus for laminating webs of suitable material, said apparatus including means for receiving said webs in co-planar relation,

electromagnetic energy radiating means for radiating electromagnetic energy in a zone smaller in area than the opposed surfaces of the webs, said zone extending through the webs;

means for permitting relative movement of said electromagnetic energy to said webs so that said zone will traverse substantially the whole of the opposed surfaces of said webs where lamination is required, the radiating means being such that electromagnetic energy will be absorbed in said zone to effect heating to laminating temperatures to allow laminating.

Said means for permitting relative movement comprises a conveyor means for moving said webs relative to said radiating means.

Said zone extends across said webs in a direction perpendicular to the direction of relative movement.

Squeezing means is provided for applying a squeezing pressure to the opposed faces of said webs to enhance laminating.

Said squeezing means is provided upstream of said zone whereby to minimize the volume of air between the webs during laminating.

Said squeezing means is provided downstream of said zone.

Also there is sensing means for sensing characteristics of said webs, control means connected to said said sensing means, said control means having an output for controlling said means for permitting relative movement and said electromagnetic energy radiating means whereby to provide control of said laminating.

It will be apparent to those skilled in the relevant arts that various alterations and modifications may be made to the apparatus and process for producing a laminate as described above, without departing from the basic concepts of the invention. All such modifications and alterations are to be considered within the scope of the invention, the nature of which is to be determined from the foregoing description and the appended claims.

CLAIMS

1. A process for producing a laminate, said process including the steps of,

(a) providing at least two webs of suitable material to be laminated and placing the webs in co-planar relation,

(b) generating electromagnetic energy and radiating said energy in a zone smaller in area than the area of the opposed surfaces of the webs, said zone extending in a direction through the thickness of said webs,

(c) providing relative movement of said electromagnetic energy to said web so that the zone will transverse substantially, the whole of the opposed surfaces of said webs where lamination is required,

the radiating of said energy in said zone being such as to cause absorption of electromagnetic energy to effect heating to laminating temperatures, and

(d) allowing laminating of said webs following said heating.

2. A process as claimed in claim 1, wherein said process includes the further step of providing an interleave between the webs and wherein said heating heats said interleave in said zone to laminating temperatures.

3. A process as claimed in claim 1 or claim 2 wherein there is continuous relative movement of said at least two webs relative to said zone to provide for continuous laminating.

4. A process as claimed in any one of the preceding claims including the further step of applying a squeezing pressure to the opposed faces of said webs to enhance said laminating.

5. A process as claimed in claim 4, wherein said squeezing pressure is applied to an area of said webs upstream of said zone whereby to minimize the volume of air between the webs.

6. A process as claimed in claim 4, wherein said squeezing pressure is applied to an area downstream of said zone.

7. A process as claimed in any one of the preceding claims wherein a further web is laminated to said laminate by a further relative movement of said further web to said zone.

8. A process as claimed in claim 7 wherein said further web is closer to a source of said electromagnetic energy than said laminate whereby there will be greater energy absorption between said further web and said laminate, than between the webs in said laminate.

9. A laminate produced by the process of any one of claims 1 to 8.

10. A laminate as claimed in claim 8 wherein said webs are glass.

11. A laminate as claimed in claim 10 wherein there is an interleave of P.V.B. between said webs.

12. Apparatus for laminating webs of suitable material, said apparatus including means for receiving said webs in co-planar relation,

electromagnetic energy radiating means for radiating electromagnetic energy in a zone smaller in area than the opposed surfaces of the webs, said zone extending through the webs;

means for permitting relative movement of said electromagnetic energy to said webs so that said zone will traverse substantially the whole of the opposed surfaces of said webs where lamination is required, the radiating means being such that electromagnetic energy will be absorbed in said zone to effect heating to laminating temperatures to allow laminating.

13. Apparatus as claimed in claim 12 wherein said means for permitting relative movement comprises a conveyor means for moving said webs relative to said radiating means.

14. Apparatus as claimed in claim 12 or claim 13 wherein said zone extends across said webs in a direction perpendicular to the direction of relative movement.

15. Apparatus as claimed in any one of claims 12 to 14 wherein squeezing means is provided for applying a squeezing pressure to the opposed faces of said webs to enhance laminating.

16. Apparatus as claimed in claim 15 wherein said squeezing means is provided upstream of said zone whereby to minimize the volume of air between the webs during laminating.

17. Apparatus as claimed in claim 15 or claim 16 wherein said squeezing means is provided downstream of said zone.

18. Apparatus as claimed in any one of claims 12 to 17 including sensing means for sensing characteristics of said webs, control means connected to said said sensing means, said control means having an output for controlling said means for permitting relative movement and said electromagnetic energy radiating means whereby to provide control of said laminating.

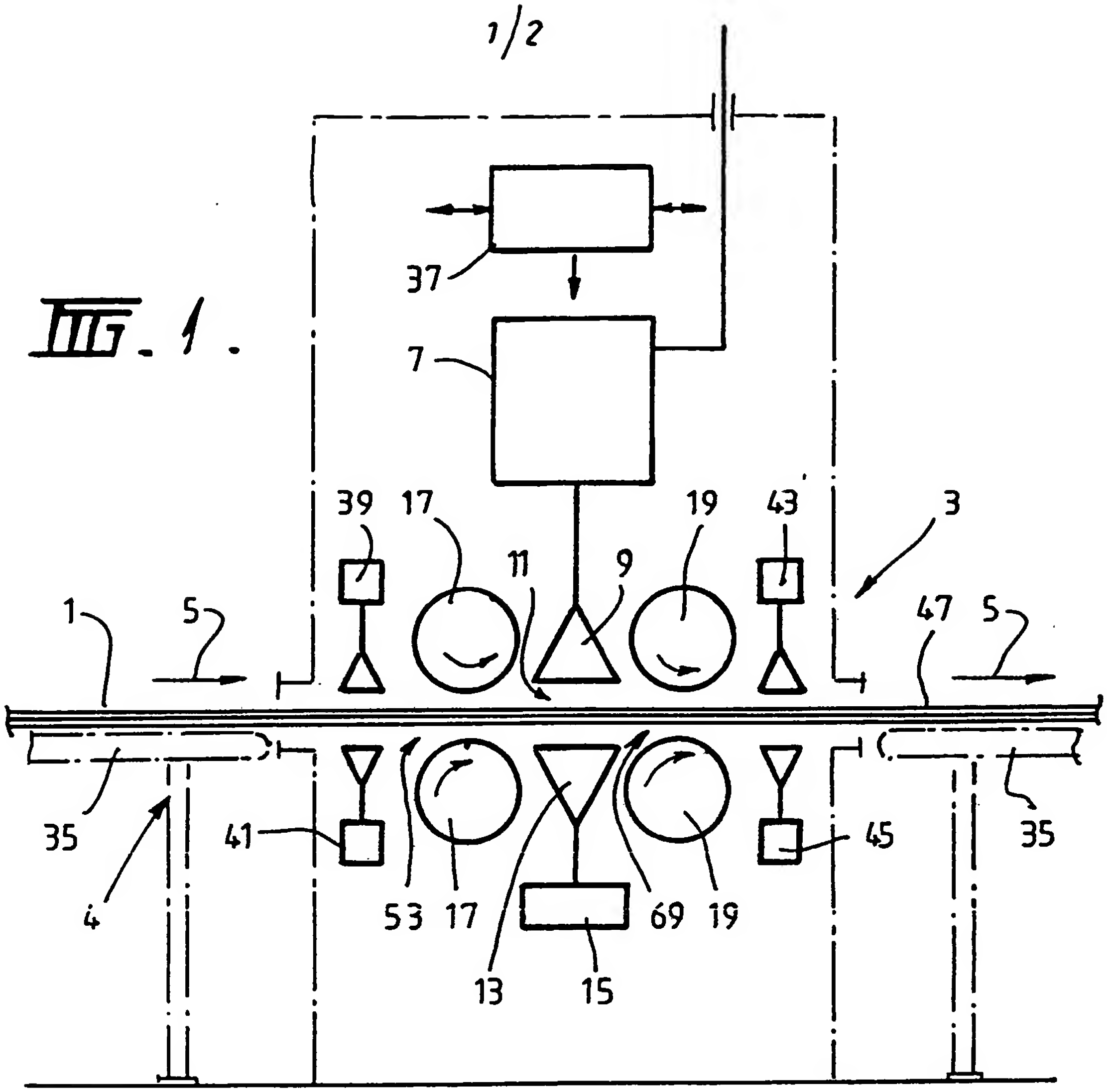

FIG. 1.

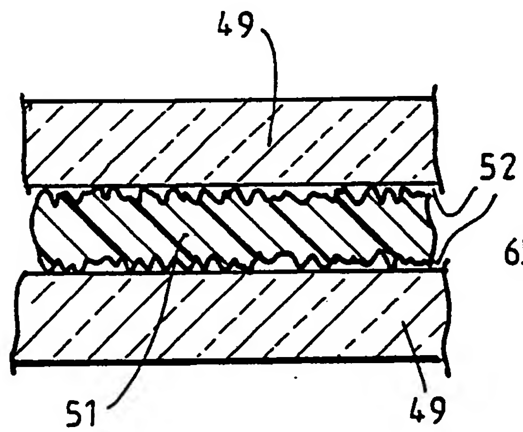

FIG. 2.

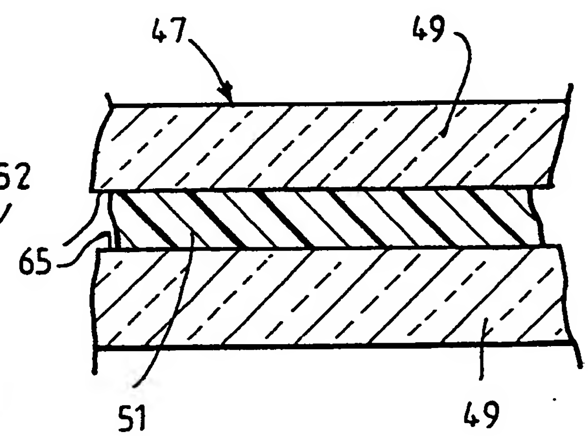

FIG. 3.

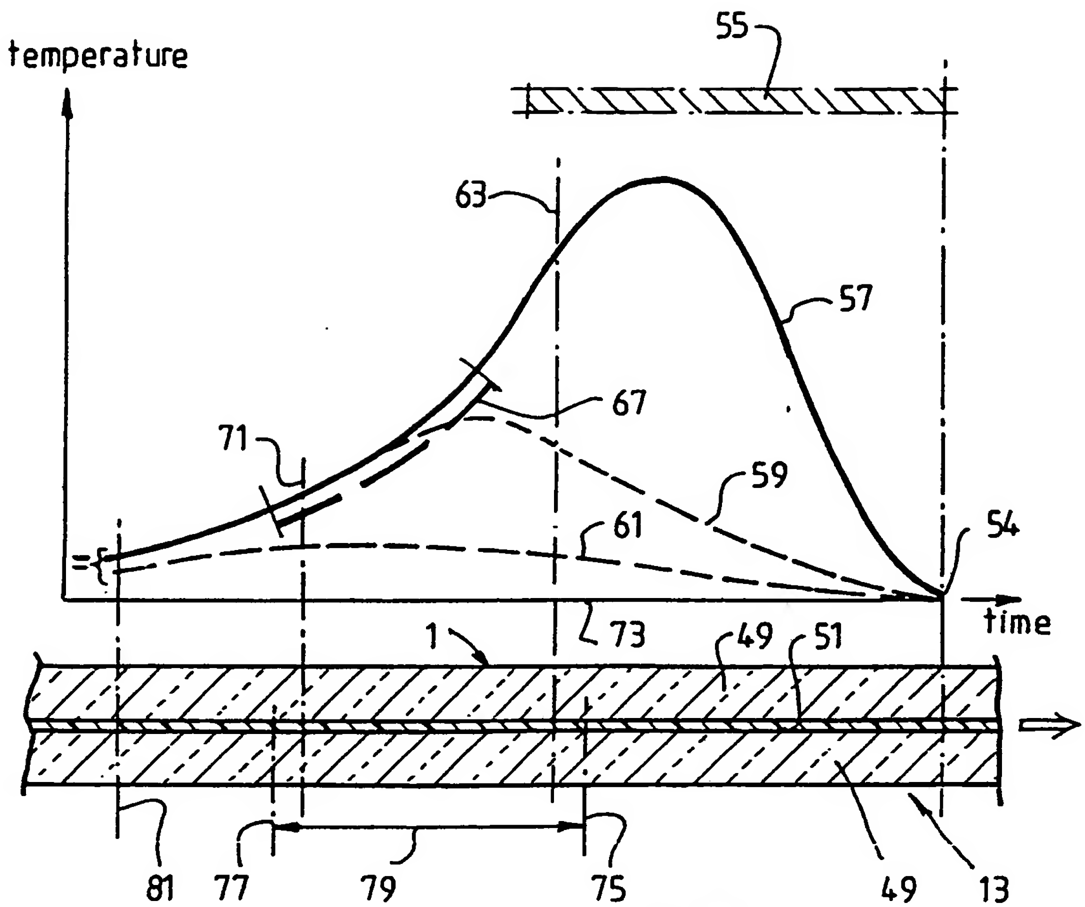

FIG. 4.

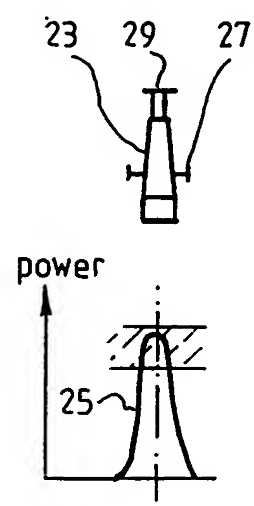

FIG. 5a.

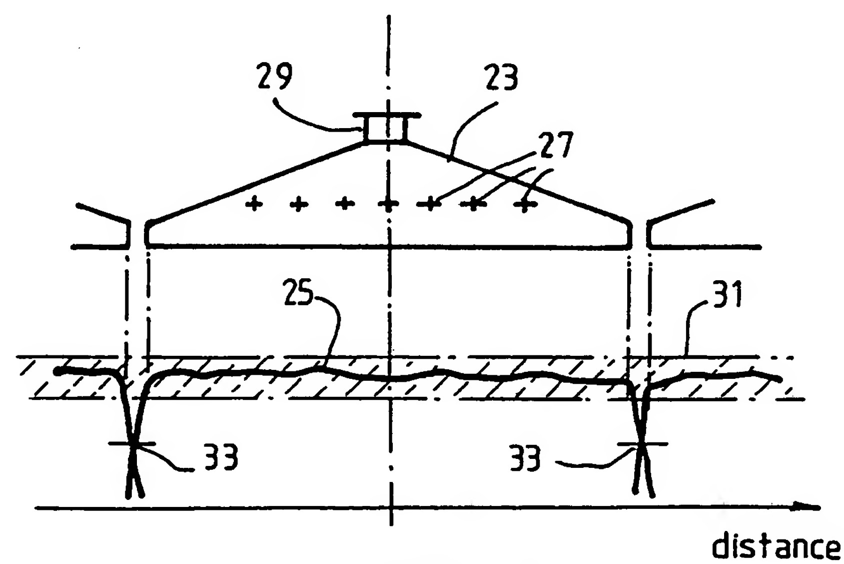

FIG. 5b.

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 87/00364

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{4} C03C 27/12, B32B 31/28, 17/10, 17/06

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	C03C 27/12

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	Derwent Abstract Accession no. 83-780590/40 Class P73, JP,A, 58-145645 (BRIDGESTONE TIRE K.K.) 30 August 1983 (30.08.83)	(1-10,12-18)
X	Derwent Abstract Accession no. 59915K/25 Class P73, JP,A, 58-79849 (BRIDGESTONE TIRE K.K.) 13 May 1983 (13.05.83)	(1-10,12-18)
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* Special categories of cited documents:

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8 February 1988 (08.02.88)	(18.02.88) 18 FEBRUARY 1988
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	R. SAWYER

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 87/00364

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END OF ANNEX